ICS ELECTRONICS CORPORATION

1983

# MODEL 4886B
# IEEE 488 Bus Extender
# Interface Manual

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# Interface Manual

ICS ELECTRONICS CORPORATION

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San Jose, CA 95112

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# 1

# Specifications

## 1.1 DESCRIPTION

### 1.1.1 4886B IEEE BUS Extender

The ICS Model 4886B IEEE Bus Extender (Figure 1-1) is designed to extend a local IEEE 488 Bus to an IEEE 488 Bus at a remote location. This transparent Bus extension is accomplished by connecting two model 4886Bs, one at each Bus, in a back-to-back configuration. All communication between the two model 4886Bs is performed serially, using a special 4886B protocol. Dedicated twisted pair lines may be used for short distance extensions, not to exceed 4,000 feet. Alternatively, each Model 4886B may be connected to a modem and the serial connection may be made over the telephone Direct Dial Network.

The Model 4886B Bus Extenders may be used with telephone Auto-Dialers (-A option) and in multi-drop applications. The Model 4886B is compatible with 801A, 801C, or equivalent telephone dialers, and can be instructed to call a remote 4886B. After the call is completed, the two 4886Bs will establish the serial communication link between the two Buses and notify the originating controller. Multi-drop DDN applications use a separate phone number for each remote Bus location. If the remote 4886B's are equipped with the -A option, they can be instructed to sense an SRQ on the remote Bus and use prestored phone numbers to call the local 4886B to establish a link and pass the SRQ onto the Bus Controller. The 4886B Bus Extender can also be used in a private line multi-drop application. In both cases, only the "called" Bus Extender will communicate with the originating Bus Extender.

The Model 4886B Bus Extenders are transparent devices for most Bus commands and all Bus data. The only exception to the Bus commands are those dealing with the local 4886B's own address and the Bus Parallel Poll command. The Model 4886B Bus Extender has its own Bus device address so the Bus Controller can send the local extender dialing instructions and request back the local extender's status.

A unique feature of the Model 4886B Bus Extender is its ability to automatically locate the system controller and the controller-in charge. Each extender powers up in a neutral condition. The first extender to receive a Bus command becomes the local (originating) extender and passes the command on to the now remote extender. Passing control from the local controller to a remote controller will automatically reverse the extenders' functions.

The ICS 4886B Bus Extenders are command compatible with the HP 37201A HP-IB[1] Extenders and in most cases can be directly substituted for the HP Extenders without changing the controller's software. (NOTE - ICS's 4886B has a unique serial communications protocol and is intended only to communicate with other 4886B Extenders.) In addition, the ICS Bus Extenders perform some additional functions which are not included in the HP extender command set. The 4886Bs will perform a Parallel Poll[2] on the remote Bus, but it cannot respond to the controller on the main Bus within the required time limit. The response from Parallel Polling the remote Bus will be sent back to the master Bus Extender so the Bus Controller can read it during the next Parallel Poll.

Several error checking features ensure the data integrity of any system using the 4886B extenders. A self-test diagnostic routine at power turn-on or when the 4886B is reset performs a functional check of the 4886B. The remote 4886B's presence and data link is continuously checked during data transmission idle time. Automatic data retransmission upon detection of data drop-out or transmission errors ensures data link integrity.

**Figure 1-1 Model 4886B IEEE Bus Extender**

---

1 HP-IB is a registered trademark of Hewlett-Packard, Palo Alto, California and stands for their implementation of the IEEE Standard 488 Bus.

2 Early 4886Bs, designated as Revision 'E' type units, do not support Parallel Poll.

### 1.1.2 IEEE 488 BUS

The IEEE 488 Bus transfers data and commands between the components of an instrumentation system on 16 signal lines. The interface functions for each system component are performed within the component so that only passive cabling is needed to connect the system. The cables connect all instruments, controllers, and other components of the system in parallel to the signal line as shown in Figure 1-2. Eight of the lines (DI01-DI08) are reserved for the transfer of data and other messages in a byte-serial, bit-parallel manner. Data and message transfer is asynchronous, co-ordinated by the three handshake lines (DAV, NRFD, NDAC). The other five lines are for control of Bus activity.

Devices connected to the Bus may be talkers, listeners, or controllers. The controller dictates the role of each of the other devices by setting the ATN (attention) line true and sending talk or listen addresses on the data lines (DI01-DI08). Addresses are set into each device at the time of system configuration either by switches built into the device or by jumpers on a PC board. While the ATN line is false, only devices that have been addressed will actively send or receive data. All others ignore the data lines.

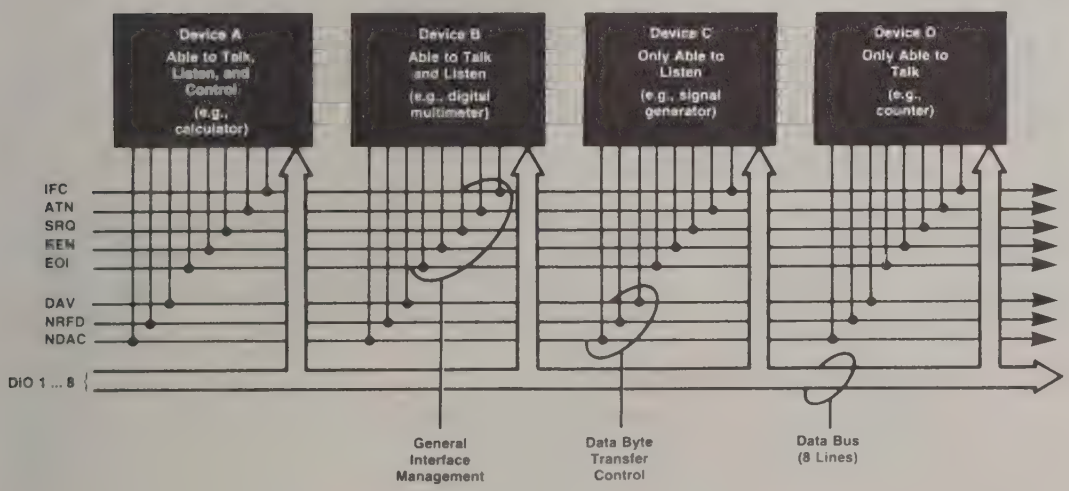



**Figure 1-2 IEEE 488 BUS**

Several listeners can be active simultaneously, but only one talker can be active at a time. Whenever a talk address is put on the data lines (while ATN is true), all other talkers will be automatically unaddressed.

Information is transmitted on the data lines under sequential control of the three handshake lines. No step in the sequence can be initiated until the previous step is completed. Information transfer can proceed as fast as devices can respond,

but no faster than allowed by the slowest device presently addressed as active. This permits several devices to receive the same message byte concurrently.

The ATN line is one of the five control lines. When ATN is true, addresses and universal commands are transmitted on only seven of the data lines using the ASCII* code. When ATN is false, any code of 8 bits or less understood by both talker and listener(s) may be used.

The other control lines are IFC, REN, SRQ, EOI.

IFC (interface clear) places the interface system in a known quiescent state.

REN (remote enable) is used with other coded messages to select either local or remote control of each device.

Any active device can set the SRQ (service request) line true. This indicates to the controller that some device on the Bus wants attention, such as a counter that has just completed a time-interval measurement and wants to transmit the reading to a printer.

EOI (end or identify) is used by a device to indicate the end of a multiple-byte transfer sequence. When a controller sets both the ATN and EOI lines true, each device capable of a parallel poll indicates its current status on the DIO line assigned to it.

In the interest of cost-effectiveness it is not necessary for every device to be capable of responding to all the lines. Each can be designed to respond only to those lines that are pertinent to its function on the Bus.

## 1.2 DETAIL SPECIFICATIONS

In general, the following specifications apply to all Model 4886B series IEEE Bus Extenders. Exact specifications for your model may be found by comparing its model and option numbers against the listed specifications. All numbers in parenthesis refer to referenced manual paragraph numbers.

### 1.2.1 Model Number Designation

4886B - X ——— General Model Number

└——— Option Code(s)

| | |
|---|---|
| -1 | Special Crystal |
| -3 | Special Paint |
| -4 | No logo on front panel |
| -5 | Custom logo on front panel |
| -7 | Special Program |
| -A | Auto-Dialer option (1.2.8) |
| -E | 230 Vac power |
| -J1 | 100 Vac power |
| -J2 | 200 Vac power |

└——— IEEE 488 Bus Extender Model Number (115 Vac Std)

* American Standard Code for Information Interchange

### 1.2.2 IEEE 488 Bus Specifications

| | |
|---|---|
| Form | Sixteen lines, eight for data and eight for control and status messages. Data transfer is byte serial using 3 wire handshake and meets IEEE STD 488-1978. |
| Interface | Driver and receiver circuits are TTL compatible. Open collector drivers sink 48mA each and drive over 20 meters of cables. Model 4886B uses the IEEE 488 standard 24 pin connector with metric studs. |
| Address Capability | Address any of 31 single addressed devices (addresses 0 thru 30) and 961 extended addressed devices. Local extender address may be any single address between 0 and 30. |
| Codes | IEEE 488 command and address messages conform to those shown in Table 1-1. Data characters can be any combination of the eight data bits. |
| Transfer Rates | Bus transfer rate is typically 3K bytes/sec active (10K bytes/sec inactive). The long term transparent command and data character transfer rate is a function of the selected baud rate, serial data link, link error rate, and the mix of command and data bytes. |

Typical long term transfer rates are given for the following error free data transmissions. Pro-rate the byte/second values for other baud rates.

| Baud Rate | Bytes/Second |
|---|---|
| 1200 | 30 to 58 |
| 9600 | 409 to 463 |
| 19,200 | 833 to 926 |
| 38,400 | 862 to 1190 |

## TABLE 1-1 IEEE 488 COMMAND AND ADDRESS MESSAGES

### ASCII — IEEE 488 BUS MESSAGES (COMMANDS AND ADDRESSES) HEX CODES

| MSD / LSD | 0 | | 1 | | 2 | | 3 | | 4 | | 5 | | 6 | | 7 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ASCII | MSG | ASCII | MSG | ASCII | MSG[1] | ASCII | MSG[1] | ASCII | MSG[1] | ASCII | MSG[1] | ASCII | MSG | ASCII | MSG |
| 0 | NUL | | DLE | | SP | 00 | 0 | 16 | @ | 00 | P | 16 | ` | | p | |
| 1 | SOH | GTL | DC1 | LLO | ! | 01 | 1 | 17 | A | 01 | Q | 17 | a | | q | |
| 2 | STX | | DC2 | | " | 02 | 2 | 18 | B | 02 | R | 18 | b | | r | |
| 3 | ETX | | DC3 | | # | 03 | 3 | 19 | C | 03 | S | 19 | c | | s | |
| 4 | EOT | SDC | DC4 | DCL | $ | 04 | 4 | 20 | D | 04 | T | 20 | d | | t | |
| 5 | ENQ | PPC | NAK | PPU | % | 05 | 5 | 21 | E | 05 | U | 21 | e | | u | |
| 6 | ACK | | SYN | | & | 06 | 6 | 22 | F | 06 | V | 22 | f | | v | |
| 7 | BEL | | ETB | | ' | 07 | 7 | 23 | G | 07 | W | 23 | g | | w | |
| 8 | BS | GET | CAN | SPE | ( | 08 | 8 | 24 | H | 08 | X | 24 | h | | x | |
| 9 | HT | TCT | EM | SPD | ) | 09 | 9 | 25 | I | 09 | Y | 25 | i | | y | |
| A | LF | | SUB | | * | 10 | : | 26 | J | 10 | Z | 26 | j | | z | |
| B | VT | | ESC | | + | 11 | ; | 27 | K | 11 | [ | 27 | k | | ( | |
| C | FF | | FS | | , | 12 | < | 28 | L | 12 | \ | 28 | l | | ¦ | |
| D | CR | | GS | | - | 13 | = | 29 | M | 13 | ] | 29 | m | | ) | |
| E | SO | | RS | | . | 14 | > | 30 | N | 14 | ^ | 30 | n | | ~ | |
| F | SI | | US | | / | 15 | ? | UNL | O | 15 | _ | UNT | o | | DEL | |

MEANING DEFINED BY PCG CODE

ADDRESSED COMMAND GROUP

UNIVERSAL COMMAND GROUP

LISTEN ADDRESS GROUP

TALK ADDRESS GROUP

SECONDARY COMMAND GROUP

PRIMARY COMMAND GROUP (PCG)

Notes:

1. Device Address messages shown in decimal
2. Message codes are:
   DCL — Devices Clear
   GET — Device Trigger
   GTL — Go to Local
   LLO — Local Lockout
   PPC — Parallel Poll Configure
   PPU — Parallel Poll Unconfigure
   SDC — Selected Device Clear
   SPD — Serial Poll Disable
   SPE — Serial Poll Enable
3. ATN off, Bus data is ASCII; ATN on, Bus data is an IEEE MSG.

### 1.2.3 IEEE 488 Bus Interface Function

The 4886B transparently passes all Bus functions to the remote 4886B except for Parallel Poll (See Section 1.2.4.1). The remote 4886B functions like a controller with C9 capability.

The 4886B has the following Bus capabilities for its internal functions:

| IEEE 488 CODE | CAPABILITY |
|---|---|
| SH1 | Source Handshake |
| AH1 | Acceptor Handshake |
| T6 | Basic Talker, can be Serial Polled (responds with Status Byte). Does not talk if addressed to listen |
| L4 | Basic Listener, does not listen if addressed to talk |
| TE0 | Not an Extended Talker |
| LE0 | Not an extended Listener |
| SR1 | Service Requester |
| RL0 | Cannot be placed in Local or Remote control |
| PP0 | No response to Parallel Polls |
| DC0 | No responce to Device Clear |
| DT0 | No response to Device Trigger |
| C0 | No capability |
| E1 | Open collector drivers |

### 1.2.4 Extender Transparent Functions

Basically, one Model 4886B Bus Extender converts the IEEE Bus bit parallel format into a serial format for transmission to the other 4886B, which then converts the serialized information back to a bit parallel form for handshaking to the devices connected to the second Extender. Except for timing restrictions on the Parallel Poll response message, the entire set of IEEE commands listed in Table 1-1 can be extended to the remote Bus. Internal logic guarantees that the 4886B meets all of the IEEE 488 response times on its local Bus interface.

The 4886B has an internal buffer which stores up to 50 Bus commands or data characters for transmission to the remote extender. The 4886B loads this buffer at the high Bus transfer rate to minimize the time the controller must spend outputting data to the Bus. The 4886B can also be instructed to interrupt the controller when the buffer is empty.

#### 1.2.4.1 PARALLEL POLL RESPONSE

Parallel Poll response from the remote Bus is delayed by the turn around time of the serial data path between the two 4886Bs. The local 4886B stores the response character from the remote 4886B and then outputs it to the local controller in response to a subsequent Parallel Poll. Minimum Parallel Poll response time from the remote Bus is 20 msec plus the serial path turn around time.

### 1.2.4.2 COMMUNICATION PROTOCOL

The 4886B serial communication protocol is basically the same regardless of the type of serial data communication path used to interconnect the two 4886Bs. Command sequences and data messages are assembled into variable length blocks of non-ASCII characters for transmission to the other 4886B. Vertical parity bits and longitudinal check characters are included with each message block to catch transmission errors. If the receiving 4886B detects a transmission error, it requests a retransmission of the faulty message block. The transmitting extender stores the original message block for the times shown in the following table. For error free operation, do not use a serial transmission medium with turn around times exceeding the message storage times shown below.

| Baud Rate | 4886B Message Storage Time | Recommended Serial Link | Anticipated Link Turn around Time |
|---|---|---|---|
| 300 | 12.0 Sec | 103 equivalent Modem | 1.50 Sec |
| 1200 | 3.0 | 212 equivalent Modem | .86 |
| 9600 | .375 | Synchronous Modem | .05 |
| 19.2K | .190 | Synchronous Modem or Twisted Pair Asynchronous | .03 |
| 38.4K | .160 | Twisted Pair Asynchronous | .02 |

### 1.2.4.3 DATA ERROR RATES

Error free Bus-to-Bus data transmission with single bits errors of 1 in $10^4$ bits over the entire baud range or 1 in $10^3$ at 1200 baud or less. Occasional data errors may occur when the 4886Bs are operated in a multi bit error environment if the error pattern satisfies all of the 4886B's data checks. The 4886Bs will not establish a link over a transmission medium that has a single bit error rate in excess of 1 in $10^4$ bits.

## 1.2.5 Extender Internal Functions

The Model 4886B Extender performs several functions under control of the local Bus Controller. The Bus Controller communicates with the 4886B over the IEEE 488 Bus by addressing the 4886B as it would any other Bus device with the Bus function subset capabilities listed in Section 1.2.3. The following paragraphs describe the 4886B's Internal Functions.

### 1.2.5.1 SERVICE REQUEST (SRQs)

The 4886B Bus Extender can request service on its own right when any one of the following conditions occurs:

1. Local transmit buffer is empty (DIO8)
2. Cannot send data to remote 4886B (DIO5)
3. Cannot complete dialing function or reach multi-drop 4886B (3 tries max.) (DIO3)
4. Call complete or multi-drop 4886B reached (DIO4)

### 1.2.5.2 SERIAL POLL RESPONSE

The 4886B provides the following Serial Poll Response Word:

| DIO Bit | | Meaning |
|---|---|---|
| 1 | | Data Carrier Detect line status |
| 2 | | Data Set Ready line status |
| 3 | * | Cannot complete connection (1.2.5.1-3) |
| 4 | * | Connection Complete (1.2.5.1-4) |
| 5 | * | Cannot send data to remote 4886B (1.2.5.1-2)[4] |
| 6 | * | Remote SRQ detected |
| 7 | | 4886B Request Service Bit |
| 8 | * | Local SRQ generated when transmit buffer is empty (1.2.5.1-1) |

* causes bit 7 to be set

### 1.2.5.3 4886B TALK OUTPUT STATUS MESSAGE

The 4886B outputs a four byte status message when addressed to Talk. The status message ends with EOI asserted during the fourth byte. The four bytes and their functions are:

| Byte | Function |
|---|---|
| 1 | Repeats Serial Poll Response Character |
| 2 | Auto-Dialer Status Bits or 00 Hex if no -A option |
| 3 | Last Multi-Point station successfully reached or last remote 4886 address in response to a 'W' command |
| 4 | 4886B Command Status Register |

Byte bit assignments are:

Byte 1 - Same as shown in 1.2.5.2

Byte 2 - Dialer control line status (1=on)
D101 - Call Organization Status (COS) line
D102 - Power Indication (PSI) line
D103 - Data Line Occupied (DLO) line
D104-8 Unused

Byte 3 - Last Multi-Point station successfully addressed. Station address number will be coded as an ASCII character between 21 hex (address 1) and 2F hex (address 15). A hex 3F will be returned if no Multi-Point station is active.

Byte 4 - 4886B Function Switch Settings and Status
D101 - '1' for SRQs enabled
D102 - '1' for no buffer clear on same talk address
D103 - '1' for no clear on IFC
D104 - '1' for no untalk on serial poll
D105 - '1' if R instruction received
'0' if Q instruction received or power-on reset
D106 - '1' if S instruction received and buffer not empty
D107 - '1' if local 4886B is active
D108 - Unused

---

[4] A 4886B will power up or reset with this Service Request active until a link is established.

1.2.5.4 4886B LISTEN INPUTS

The 4886B accepts the following inputs when addressed as a listener:

1. ASCII coded alpha function commands
2. Up to 32 digits of ASCII coded numbers for controlling the Auto-Dialer.
3. A single ASCII character for addressing a remote 4886B in a multi-drop circuit.

The 4886B Command inputs are:

I - Enter Idle Mode
A - Enter Active Mode
D - Disconnect a switched-network telephone connection or multi-drop 4886B
S - Send all existing data in the 4886B's buffer and generate an SRQ when the buffer is empty. The SRQ resets the S command.
E - Inhibits clearing the remote-transmit and local-receive buffers when a new talk address is issued if it is the same as the last talk address
F - Reverses E and enables buffer clearing on each Talk address
V - Inhibits addition of UNT command after a Serial Poll Disable (SPD)
U - Reverses V and adds a UNT command after each SPD command
R - Enables clearing local transmit buffer after loss of remote data if SRQs are enabled
Q - Reverses R
N - Start of telephone number identifier
T - End of telephone number identifier
M - Multi-Point address identifier
W - Requests Remote extender's back panel address switch setting (not used in multi-drop mode)
X - Re-dial previous telephone number
B - Stores following telephone number in the 4886B's internal memory
C - Requests 4886B to output telephone number when made a talker

## 1.2.6 Transmission Mediums

The Model 4886B Bus Extender is capable of operation with the following types of serial data links. The selected data link must meet the turn around times listed in 1.2.4.2.

| | |
|---|---|
| Asynchronous Modem | 103/212 or similar full duplex modems. Asynchronous data rates run from 110 to 38,400 baud. |
| Synchronous Modem | Modem clock determines exact baud rate or 4886B uses internally generated clock. Data rates vary up to 38.4K baud or are externally generated. |
| Twisted Pair Cables | Uses two twisted pair lines in one cable. Signalling rate selectable up to 38.4K with asynchronous data transmission. Maximum cable length is 4,000 feet (1200 meters) per EIA RS-422. |

| | |
|---|---|
| Multidrop Operation | Uses either two twisted pair lines in one cable or modems. Where twisted pair cable is used, the local 4886B can drive up to 9 remote 4886Bs as long as the cable design criteria of paragraph 2.6.3 are met. |

### 1.2.7 Serial Data Interface

The Model 4886B Bus Extender's serial data interface is compatible with EIA RS-449/RS-232 and CCITT V.24 modems. The 4886B's serial interface may be connected in a party-line fashion to other 4886Bs when they are used in a multi-drop system. The serial interface uses a DC-37P, 37 pin male connector. The 4886B's Serial Interface contains both RS-232 single ended drivers and RS-422 balanced line drivers. The receivers can accept either balanced or unbalanced inputs. The EIA RS-449 logic levels are RS-232 and V.24 compatible if cable lengths are kept less than 5 meters.

#### 1.2.7.1 RS-232 SPECIFICATIONS

| | |
|---|---|
| Signals | BA, BB, CA, CB, CC, CF and CD. Signal ground is AB, shield is AA |
| Transmit Levels | +5Vdc for binary 0 or On<br>-5Vdc for binary 1 or Off |
| Receive Levels | ±.2Vdc minimum, ±25 Vdc maximum |

#### 1.2.7.2 RS-422 SPECIFICATIONS

The 4886B Bus Extender provides all of the signals specified by EIA RS-449 for a Send-Receive data transmission configuration. The RS-449 signals and their RS-232 equivalents are listed in Section 2.5.

| | |
|---|---|
| Signals | CS, DM, RD, RR, RS, RT, SD, ST, TR and TT as balanced lines<br>IC, SI, and TM are single ended inputs. Signal returns are SG, SC, and RC |
| Transmit Levels | +5Vdc differential for binary 0 or On<br>-5Vdc differential for binary 1 or Off |
| Receive Levels | ±.2Vdc minimum, ±25Vdc maximum differential or single ended input |

#### 1.2.7.3 SELECTABLE BAUD RATES

The 4886B provides the following switch selectable internally generated rates: 110, 150, 300, 600, 1200, 1800, 2000, 2400, 4800, 9600, 19,200, and 38,400 baud. Baud rate accuracy is ±0.05% except 1800 and 2000 baud accuracy is ±0.4%.

### 1.2.8 Auto-Dialer Interface Option

The Model 4886B Bus Extenders with the -A option are designed to operate with RS-366 or CCITT V.25 compatible Automatic Dial Equipment. The 4886B's Auto-Dialer Interface utilizes single ended RS-423 drivers and receivers to provide compatibility with both the current and new dialer designs. The Auto-Dialer Interface logic levels are specified in Section 1.2.7.1. Recommended dialers are: Bell Model 801A, Bell Model 801C or their equivalent. The dialer interface uses a DB-25 type, male connector.

Units equipped with the -A option may be used at remote sites to reverse dial back to the local 4886B when they sense an SRQ on the remote Bus. The user stores up to three phone numbers, up to a maximum of 32 digits each, in the 4886B's internal memory. -A option units incorporate battery backed up CMOS memories which hold the stored numbers for a minimum of 4 years (5 years typical). If the remote 4886B is not linked to the local 4886B when it senses an SRQ, it will try dialing the first number. After three times, it will try the second number, if any, and then continue thru the remaining numbers, trying each number three times, and repeating the sequence over again until it can establish a link with the local 4886B. The user may program and verify the phone numbers with any IEEE 488 Bus controller.

### 1.2.9 Indicators

| Indicator | Function |
|---|---|
| POWER | Power on and unit operational. |
| READY | Serial interface handshake lines high and can transmit to the remote 4886B. Off if serial interface not connected and blinks if another 4886B has temporarily ceased accepting new serial data because of error detection or buffer full condition. |
| LINK | Remote 4886B on line and ready to accept data. |
| MTA | Local 4886B has recognized its talk address. |
| MLA | Local 4886B has recognized its listen address. |
| ERROR | Momentarily on when messages are being retransmitted after data link errors. |
| DIALING | Local 4886B dialing a remote 4886B. Blinks if telephone line busy or ringing or no response from remote 4886B. Goes off when LINK comes on. |

### 1.2.10 Controls

| | |
|---|---|
| POWER | Alternate action switch. |
| RESET | Momentary action push button that clears the 4886Bs' internal logic. |

| | |
|---|---|
| DTR OFF | Momentary action push button that lowers DTR to manually disconnect dial up telephone links. |
| 115/230 | Internal slide switch selects 115/230Vac power. |
| ADDRESS SW | Rear panel rocker switch selects 4886B's address and operating modes. |
| CHAR FMT & RATE | Rear panel rocker switch that selects serial character format, baud rate and sync/async operation. |

### 1.2.11 Physical

| | |
|---|---|
| DIMENSIONS | 8.6 in. wide x 3.4 in. high x 11.4 in. deep (21.9 cm wide x 8.6 cm high x 29.0 cm deep), excluding connectors. Outline dimensions shown in Figure 1-3. |
| WEIGHT | 6.4 pounds (2.9 kgm) |
| CONNECTORS | RS-499 Serial Data Interface-Cinch DC-37P<br>RS-366 Dialer Interface-Cinch DB-25P<br>IEEE 488 Interface-Amphenol 57-20240 with metric lock studs |
| POWER REQUIREMENTS | 110/115/200/230 Vac $\pm$ 10%, 48-62Hz,<br>35 watts max.<br>Fuse - 3AG, 0.5 ampere for 100-115 Vac<br>- 3AG, 0.25 ampere for 200 Vac<br>- 5 x 20 mm, 0.25 ampere for 230 Vac |
| TEMPERATURE | $0^{\circ}$C to $+50^{\circ}$C operating<br>$-20^{\circ}$C to $+70^{\circ}$C non-operating |

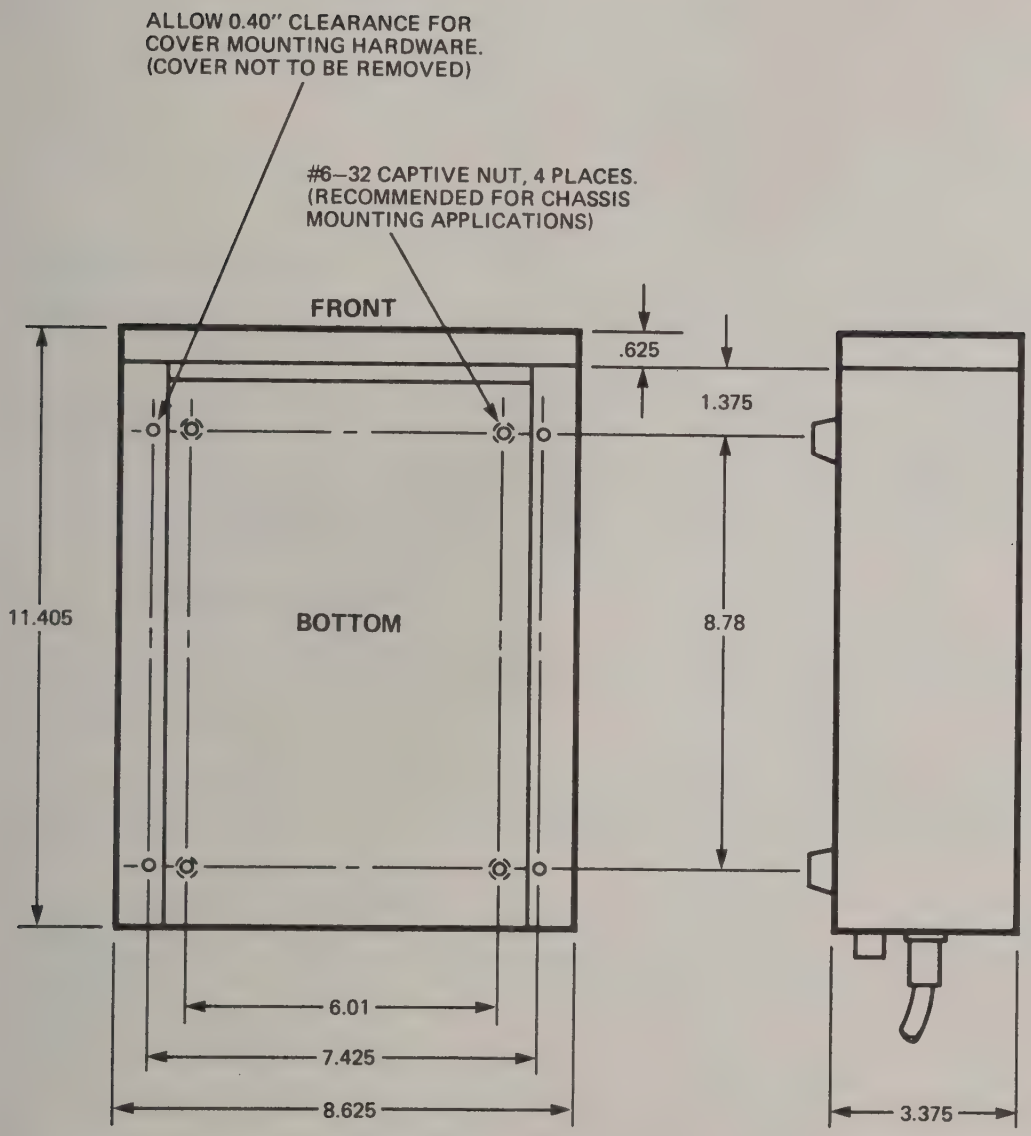
### 1.2.12 Accessories

The following accessories are supplied with each 4886B Extender.

| Part Number | Accessory |
|---|---|
| 902050 | J2 Mating connector. |
| 902105 | J2 Hood with latches. |
| 902000 | J3 Mating connector (-A option units only). |
| 902008 | J3 Hood with lock screws (-A option units only). |
| 120037 | Instruction Manual, Model 4886B IEEE 488 Bus Extender. |

The following are optional 4886B accessories which may be ordered from ICS Electronics.

| Part Number | Accessory |
|---|---|
| 112300 | Cable, 4886B to RS-232 Modem (2M long) |
| 112301 | Cable, 4886B to RS-449 Modem (2M long) |
| 112302 | Cable, 4886B to RS-366 801 A/C type auto-dialer (2M long) |
| 112303-L | Cable 4886B to 4886B for back-to-back operation. Cable made with polypropylene insulation for indoor use. L = length in meters (10M std.) |
| 112304 | Cable, 4886B multidrop daisy chain. Cable made with polypropylene insulation for indoor use. Specify lengths between 4886Bs when ordering. |
| 112259 | 4886B Field Test Prom Kit, includes diagnositc PROM, Serial Test Connector and Test Instructions. |
| 112308 | 4886B Spare Parts Kit. See Table 6-2. |
| 112317 | Adapter cable, RS-449 to RS-232 male plug with locking studs (5 inches long). |
| 112576 | Rack Mounting Kit, single unit. |
| 112577 | Rack Mounting Kit, two units. |




Notes: 1. Six foot long removable cord
2. Removable feet

**Figure 1-3 - 4886B Outline Dimensions**

# 2

# Installation

## 2.1 UNPACKING AND INSPECTION

If shipping carton or instrument is damaged, call carrier immediately, and inspect the Extender for damage (scratches, dents, etc.). If unit is damaged or fails to meet specifications, notify ICS Electronics or your local sales representative immediately. Retain shipping carton and packing material for carrier's inspection. ICS will make arrangements for unit to be repaired or replaced without waiting for claim against carrier to be settled.

## 2.2 BENCH OPERATION

The Bus Extender is ready for bench operation when shipped, with the exception of setting the rear panel address and rate switches. See Section 3.1 for switch setting instructions.

The unit is equipped with four feet for setting on other instruments. While capable of operation at elevated room temperatures, for best stability and long life, do not place the unit where it will be subjected to undue temperature rises.

## 2.3 RACK INSTALLATION

Rack installation is feasible only if a rack mounting kit was shipped with the instrument. To convert the unit for rack mounting, do the following:

a. Remove feet.

b. Slide the 4886B into the rack mounting kit from the front until the front bezel is just outside of rack mount assembly.

c. Turn the rack mount kit on its side. Line up the 4886B case feet mounting holes with those in the rack. Use the furnished screws to fasten unit in place.

d. Repeat steps a through c if a second unit is to be installed in the rack mount assembly. If a second unit is not to be installed, mount the dummy front panel in its place.

e. Install the rack mount assembly in the rack and attach cables to the unit(s).

**CAUTION**

ALWAYS REMOVE POWER FIRST
BEFORE WORKING ON THE UNITS

## 2.4 POWER CONNECTIONS

The unit has a three-prong international power outlet on the rear panel which accepts 115Vac American style or 230Vac European style power cords. The unit is shipped with the American style power cord which the user may have to adapt to other countries' power outlets by replacing the plug on the power cord.

The unit may be operated from either 100, 115, 200 or 230Vac, 50 or 60Hz power, depending upon internal switch and jumper selections. The factory power setting is marked on the units' rear panel at time of shipment.

**CAUTION**

ALWAYS CHECK THE REAR PANEL MARKING BEFORE APPLYING POWER TO A NEW UNIT OR WHEN CHANGING POWER CORDS.

To change units' power setting, do the following:

a. Disconnect all cables from the unit.

b. Remove the cover.

c. Locate the 115/230 slide switch adjacent to the power transformer. Set the switch as follows:

"115" for 90 to 130Vac power
"230" for 180 to 240Vac power

d. Locate the 100/115 jumper. Set it as follows:

"115" for 110 to 130 or 220 to 240Vac power
"100" for 90 to 110 or 180 to 220Vac power

Be sure to clean the board and carefully remove any excess solder before assembling the unit.

e. Replace the cover.

f. Change rear panel power label to show the new power setting.

## 2.5 IEEE 488 BUS CONNECTIONS

The unit is equipped with a 24-pin connector, J1, which mates with any 488 Bus Cable. All pin numbers and signals characteristics are per IEEE Specification, 488-1978. Signal pin assignments are listed for reference purposes in Table 2-1.

TABLE 2-1 488 BUS CONNECTIONS (J1)

| Pin | Signal | Pin | Signal |
|---|---|---|---|
| 1 | DI01 | 13 | DI05 |
| 2 | DI02 | 14 | DI06 |
| 3 | DI03 | 15 | DI07 |
| 4 | DI04 | 16 | DI08 |
| 5 | EOI | 17 | REN |
| 6 | DAV | 18 | DAV Ret |
| 7 | NRFD | 19 | NRFD Ret |
| 8 | NDAC | 20 | NDAC Ret |
| 9 | IFC | 21 | IFC Ret |
| 10 | SRQ | 22 | SRQ Ret |
| 11 | ATN | 23 | ATN Ret |
| 12 | Shield | 24 | Ground |

## 2.6 SERIAL CONNECTIONS

The 4886B Bus Extender has a 37 pin connector (DC-37P), J2, which contains all of the serial signals used to connect two Bus Extenders to each other. Connector J2 contains a mix of RS-422 and RS-232 signals which are used in the following types of hook-ups.

1. Back-to-back connection with dual twisted pair cables (2.6.1).
2. Back-to-back, using modems to extend the distance between the extenders (2.6.2).
3. Back-to-back, using modems over the telephone company's direct network with an Auto-Dialer (2.6.3).
4. Multi-point communication network connection using twisted pair cable (2.6.4).

Although all of the signals on connector J2 are listed in Table 2-2, it is not necessary to use all of them when interconnecting the 4886B Bus Extenders. For instance, the RS-449 handshaking signals are only included for future use with RS-449 compatible modems when they become available. To interconnect the extenders, the user should:

1. Select an interconnection method from the above list.
2. Refer to the referenced paragraph number in parenthesis for detailed directions on that method.
3. Fabricate a cable as directed in the detailed instructions using the mating connector supplied with the Bus Extender.

### 2.6.1 Back-to-Back Connections

The back-to-back connection is the simplest and provides the highest transfer rate of all four interconnection methods. (See Figure 2-1.) The interconnection cable should contain two twisted shielded pairs for maximum length and minimum cross talk. Other types of cable such as unshielded pairs or plain four conductor cables can be used but the user should expect to operate at a reduced baud rate and over a shorter distance.

## TABLE 2-2 SERIAL I/O PIN ASSIGNMENTS (J2)

| J2 PIN NO | EIA CODES RS449 | RS232 | SIGNAL FUNCTION | SIGNAL DIRECTIONS (In) | (Out) |
|---|---|---|---|---|---|
| 12 | TR | | Data Terminal Ready | | → |
| 30 | TR/ | | | | |
| 7 | RS | | Request to Send | | → |
| 25 | RS/ | | | | |
| 4 | SD | | Transmitted Data | | → |
| 22 | SD/ | | | | |
| 17 | TT | DA | Transmit Clock | | → |
| 35 | TT/ | AB | | | |
| 5 | ST | DB | Send Timing | ← | |
| 23 | ST/ | AB | | | |
| 8 | RT | DD | Receive Timing | ← | |
| 26 | RT/ | AB | | | |
| 6 | RD | BB | Receive Data | ← | |
| 24 | RD/ | AB | | | |
| 9 | CS | CB | Clear to Send | ← | |
| 27 | CS/ | AB | | | |
| 13 | RR | CF | Receiver Ready | ← | |
| 31 | RR/ | AB | | | |
| 11 | DM | CC | Data Mode | ← | |
| 29 | DM/ | AB | | | |
| 15 | IC | CE | Incoming Call | ← | |
| 18 | TM | | Test Mode | ← | |
| 20 | RC | AB | Receive Common | | |
| 10 | LL | | Local Loopback | | → |
| 14 | RL | | Remote Loopback | | → |
| 16 | SR | CH | Signal Rate Sel | | → |
| 2 | SI | CI | Signal Rate Ind | ← | |
| 34 | NS | | New Signal | | → |
| 37 | SE | AB | Send Common | | |
| 3 | | BA | Transmitted Data | | → |
| 28 | | CD | Data Terminal Ready | | → |
| 21 | | CA | Request to Send | | → |
| 19 | SG | AB | Signal Ground | | |
| 1 | SHLD | AA | Chassis Ground | | |

Notes:
1. RS-232 compatible devices connect to the RS-232 signals listed in the table. Jumper signal ground (AB) to all 10 pins shown in column.

2. RS-449 compatible devices connect to the RS-449

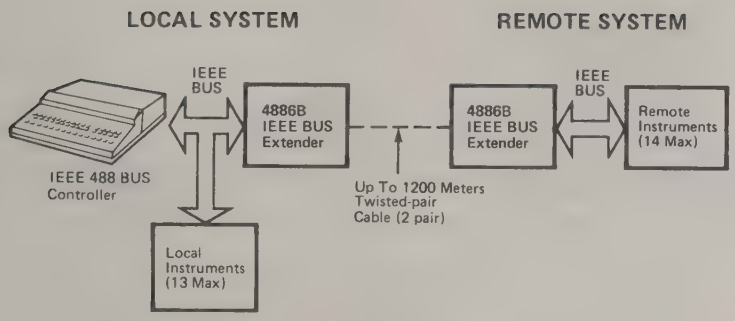



**Figure 2-1 Back-to-Back Connections**

Use the mating connectors supplied with the extenders to fabricate the back-to-back cable shown in Figure 2-3. Do not exceed 1200 meters (4,000 feet) with twisted shielded pair cable. Be sure to install the jumpers shown in the attached wire list.

Under normal conditions, satisfactory error free operation is assured with twisted shielded pair cables that do not exceed 1200 meters (4,000 feet). Longer cables may be used as long as the user maintains a bit error rate of $1 \times 10^{-6}$ or better between the two 4886Bs. Cable terminators are normally not required to achieve reliable operation of the 4886Bs with twisted shielded pair cable. Terminators are only required when the rise time is less than four times the one-way cable propagation delay time or to reduce objectionable signal reflections. Cable terminator impedance should be selected to match the cable at the operating frequency, i.e., the characteristic impedance of a typical 24 AW9, copper, twisted shielded pair cable varies from 100 to 180 ohms.

### 2.6.2 Modem Connection

Inserting a pair of modems between the Bus Extenders as shown in Figure 2-2, extends the distance between extenders beyond the 1200 meter back-to-back cable limit. The 4886B Bus Extenders should be used with full-duplex modems that enable both extenders to simultaneously transmit messages to each other. NOTE: The 4886B extenders should not be used with half-duplex modems!

The 4886B is designed to operate with full-duplex modems that are EIA RS-449, EIA RS-232 or CCITT V.24 compatible. For low speed operation, use the Bell 103, Bell 113 or equivalent modems. Those modems operate at relatively low baud rates, 110 to 600 baud work over most dial up phone lines and require the use of asynchronous characters. For higher speed operation use the Bell 212 or equivalent modems which operate at 1200 baud.

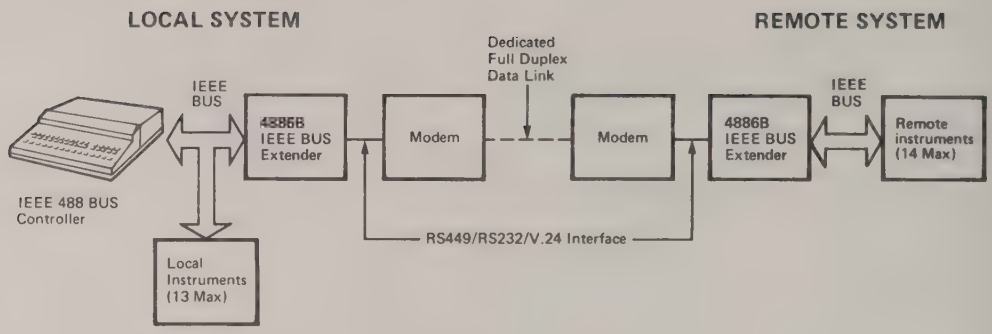



**Figure 2-2 Modem Connections**

**CAUTION**

Many of these modems (i.e., Bell 212 and equivalents) may be optioned for different asynchronous character lengths (usually 9 or 10 bits) and will need to be set at the 9-bit option for use with the 4886B Extenders.

The 4886B will also operate with higher speed, full duplex synchronous modems at 2400, 4800 and 9600 baud.

The modems may be used with private or dedicated line systems such as in airports, large factories, etc., or connected to the telephone company's direct dial network. When connected to the telephone DDN, the user will have to obtain a data access unit (DAA) at each extender location for the Bell 103/113/212 type modems. Two DAAs will be needed at each site if synchronous full duplex modems are employed. In addition, the user will have to provide a means of establishing the dial-up link such as a data set or computer operated Auto-Dialer. Section 2.7 describes connecting 4886B Extenders with the -A option to different Auto-Dialers.

The cable shown in Figure 2-4 should be fabricated to connect the 4886B Bus Extender to Bell 103, 113 or 212 type modems. Limit the cable length to 50 feet or less. All modem handshake lines must operate with the corresponding 4886B lines before the extenders can transmit data. The 4886Bs have the following requirements for the RS-232 handshake lines:

CA - 4886B sets request-to-send signal on at the end of self-test and leaves it on at all times.

| EIA Code | Signal Function | P1 Pin No. | Wiring | P2 Pin No. |
|---|---|---|---|---|
| SD | Send Data | 4 | | 6 |
| SD/ | | 22 | | 24 |
| RD | Receive Data | 6 | | 4 |
| RD/ | | 24 | | 22 |
| SG | Signal Ground | 19 | | 19 |
| TR | Data Term Rdy | 12 | | 12 |
| TR/ | | 30 | | 30 |
| RS | Req. to Send | 7 | | 7 |
| RS/ | | 25 | | 25 |
| CS | Clear to Send | 9 | | 9 |
| CS/ | | 27 | | 27 |
| RR | Receiver Ready | 13 | | 13 |
| RR/ | | 31 | | 31 |
| DM | Data Mode | 11 | | 11 |
| DM/ | | 29 | | 29 |
| IC | Ring Indicator | 15 | | 15 |
| TM | Test Mode | 18 | | 18 |
| RC | Receive Common | 20 | | 20 |
| SC | Send Common | 37 | | 37 |

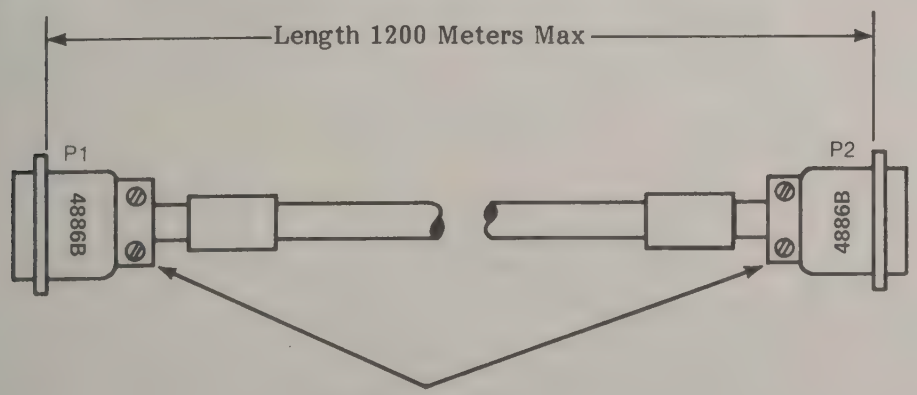
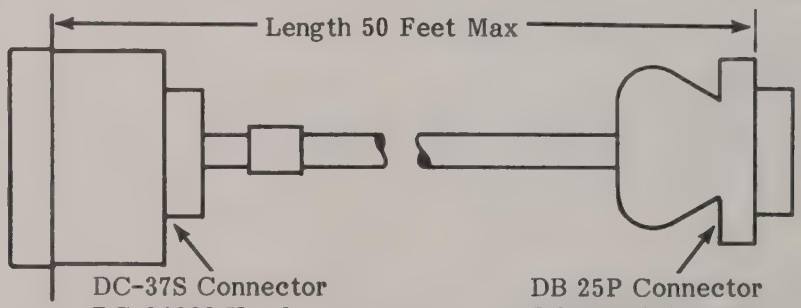



**Figure 2-3 4886B Back-to-Back Cable**

| EIA Code | Signal Function | 4886B Pin No. | Wiring | Modem Pin No. |
|---|---|---|---|---|
| AA | Chassis Gnd | 1 | | 1 |
| BA | Transmitted Data | 3 | | 2 |
| BB | Received Data | 6 | | 3 |
| BB/ | | 24 | | |
| CA | Request to Send | 21 | | 4 |
| CB | Clear to Send | 9 | | 5 |
| CB/ | | 27 | | |
| AB | Signal Gnd | 19 | | 7 |
| CC | Data Set Ready | 11 | | 6 |
| CC/ | | 29 | | |
| CF | Signal Detector | 13 | | 8 |
| CF/ | | 31 | | |
| CE | Ring Indicator | 15 | | 22 |
| CD | Data Terminal Ready | 28 | | 20 |
| | Send Common | 37 | | |
| | Receive Common | 20 | | |
| DB | Send Timing* | 5 | | 15 |
| DB/ | | 23 | | |
| DD | Receive Timing* | 8 | | 17 |
| DD/ | | 26 | | |
| RL | Remote Loopback# | 14 | | 21# |
| CH | Rate Select# | 16 | | 23# |
| CI | Signal Rate Ind# | 2 | | 12# |




Notes: * Signals needed for Sync modems only
# Optional signals, leave open if not used

**Figure 2-4 4886B to RS-232 Modem Cable**

CB - Clear to send signal must be high for the 4886B to output data. Receiving device may pull CB low to stop the data transmission. Pull CB high if not used.

CC - Data set ready and Receive signal detector lines are
CF checked to operate the ready light and both must be high for the 4886B to output data. The receiving device may pull CC low to stop the data transmission. Pull CF high if not used.

CD - Data Terminal Ready is set high when the 4886B finishes self test and initialization to indicate readiness to establish the link.

### 2.6.3 Multi-Point Operation

Several 4886B Bus Extenders can be interconnected together as shown in Figure 2-5. The network can be arranged in a star configuration, daisy chain, or any combination of the above patterns. Overall, cable length should be restricted to 1200 meters for error free operation. While one 4886B can properly drive up to 9 other 4886Bs, line terminating considerations may reduce the number of units that can be actually connected to the network.

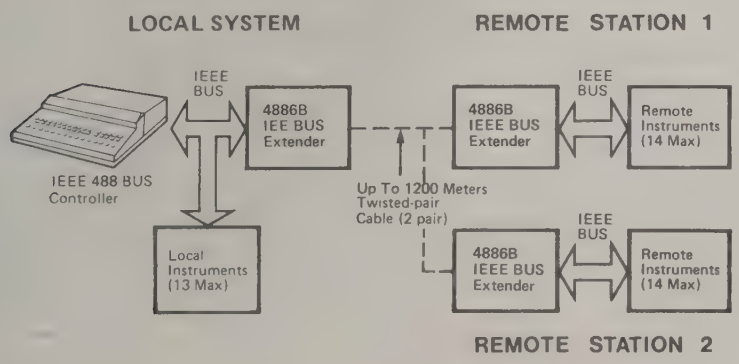



**Figure 2-5 Basic Multi-Point Connections**

The basic Multi-Point configuration uses two twisted shielded pairs to interconnect the 4886Bs. The local 4886B is wired as the transmitter and the remote 4886Bs are all wired in parallel as receivers as shown in Figure 2-6. In a daisy chain pattern, limit the number of extenders to 9. Design the cable so that a terminated cable's total load impedance is greater than 90 ohms and so that an unterminated cable's total impedance is greater than 400 ohms. Cable terminators are optional and their use depends upon the specific environment and signal quality. The cable should be designed so each 4886B receiver can assume its intended output state with an input differential voltage of less than 200mv. Common mode voltage at any receiver shall not exceed 7.0v peak. Star configuration cables may drive fewer 4886Bs due to the added cable terminators at the end of each cable stub.

| EIA Code | Signal Function | P1 Pin No. | Wiring | P2 Pin No. |
|---|---|---|---|---|
| SD | Send Data | 4 | | 6 |
| SD/ | | 22 | | 24 |
| RD | Receive Data | 6 | | 4 |
| RD/ | | 24 | | 22 |
| SG | Signal Ground | 19 | | 19 |
| TR | Data Term Rdy | 12 | | 12 |
| TR/ | | 30 | | 30 |
| RS | Req. to Send | 7 | | 7 |
| RS/ | | 25 | | 25 |
| CS | Clear to Send | 9 | | 9 |
| CS/ | | 27 | | 27 |
| RR | Receiver Ready | 13 | | 13 |
| RR/ | | 31 | | 31 |
| DM | Data Mode | 11 | | 11 |
| DM/ | | 29 | | 29 |
| CE | Ring Indicator | 15 | | 15 |
| TM | Test Mode | 18 | | 18 |
| RC | Receive Common | 20 | | 20 |
| SC | Send Common | 37 | | 37 |

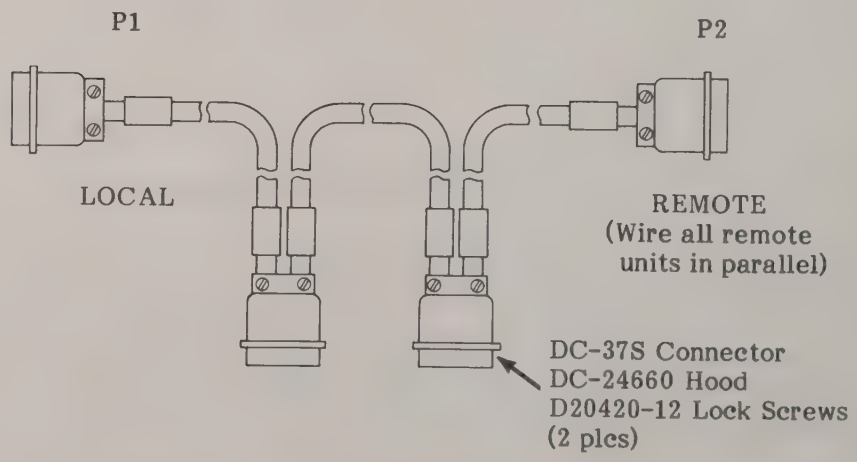



**Figure 2-6 4886B Multi-Drop Daisy Chain Cable**

The distances between the multi-drop extenders can be increased by adding modems as shown in Figure 2-7. The modems are interconnected by a private or leased (dedicated) 4 wire, full duplex circuit. The modem connected to the local extender transmits and receives continuously while only one of the other modems may be on at a time. Therefore each modem must have its carrier controlled by the associated 4886B's Request-to-Send (CA) signal. When a remote 4886B recognizes its multi-drop address, it will respond by enabling its output drivers and turning on CA before outputting any serial data.

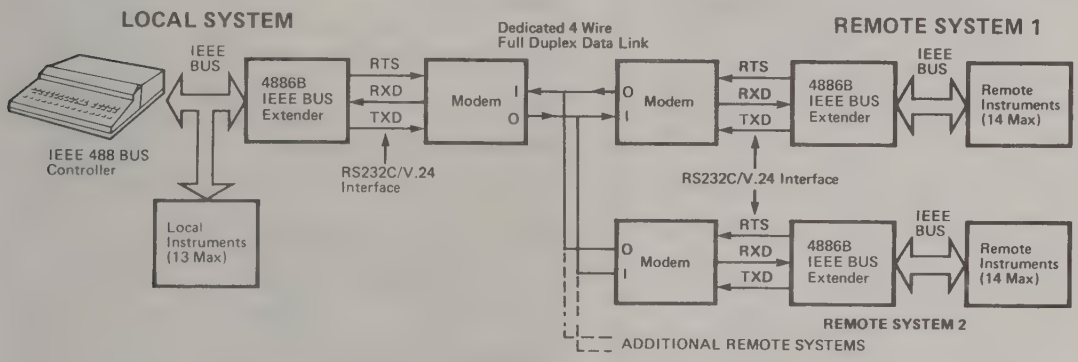



**Figure 2-7 Multi-Point Connections Using Modems**

The modems are wired to each 4886B by fabricating the modem cables described in Section 2.6.2.

## 2.7 AUTOMATIC DIALING UNITS

Model 4886B Bus Extenders with the -A (Auto-Dialer) option have a 25 pin connector, J3, which contains the Auto-Dialer control signals. These signals are in accordance with EIA RS-366 and CCITT V.25 and are compatible with Bell 801A, 801C, and equivalent Auto Dialing Units. The basic Modem-Auto Dialer connections are shown in Figure 2-8.

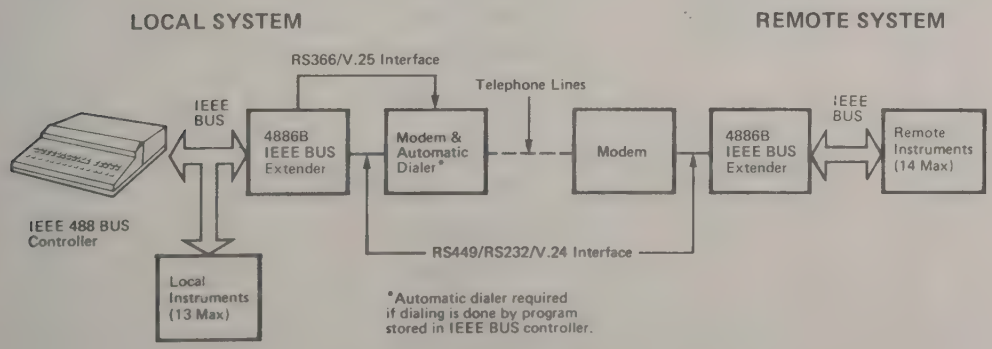



**Figure 2-8 Modem - Auto-Dialer Connection**

# 3

# Operation

## 3.1 CONTROLS

### 3.1.1 Front Panel Controls

| | |
|---|---|
| POWER | An alternate action push button that applies ac power to the interface. In is ON. |
| RESET | Momentary push button that resets the internal logic, performs an internal self test and returns the 4886B to a neutral condition. |
| DTR OFF | Momentary push button that lowers the 4886B's CD signal and manually disconnects a dialed call. In is CD OFF position. |

### 3.1.2 Address Switch

The address switch assembly sets the extender's address and establishes some operating modes. The address switch is a miniature switch assembly with eight rocker switches that is located on the rear panel as shown in Figure 3-1. From left to right, the switch positions are address bits 5, 4, 3, 2, 1, M, I and S. Address bit 5 is the MSB.

For AUTO ADDRESSING by the controller, pick an unused Bus address between 0 and 30 decimal. Convert the address to binary and write it left to right, putting the MSB on the left. Set the five address switches to the binary value, i.e., address 3 becomes:

5 4 3 2 1
0 0 0 1 1

One means the switch rocker is in the up position, zero refers to the down position.

For MULTI-DROP operation, set the address of the local extender to any unused Bus address as described above for auto addressing and set the 'M' switch up (ON). Set the addresses of the remote extenders to numbers between 1 and 15 as you would for a valid Bus address. Set each extender to a separate number and set the 'M' rocker switch on. In multi-drop system, the remote extender addresses can duplicate Bus device address because the remote extenders are only addressed by the local extender.

To PREVENT CLEARING THE 4886B's LOCAL DATA BUFFER when an IFC is received, set the 'I' rocker switch on and press RESET. This switch is normally kept in the off position since any data generated before an IFC is normally worthless and can be discarded.

For SRQ INHIBIT, set the 'S' rocker switch on and press RESET. This switch only inhibits SRQs from the local 4886B itself and does not inhibit the 4886B from passing on SRQs from the remote bus. This switch is normally kept in the down position.

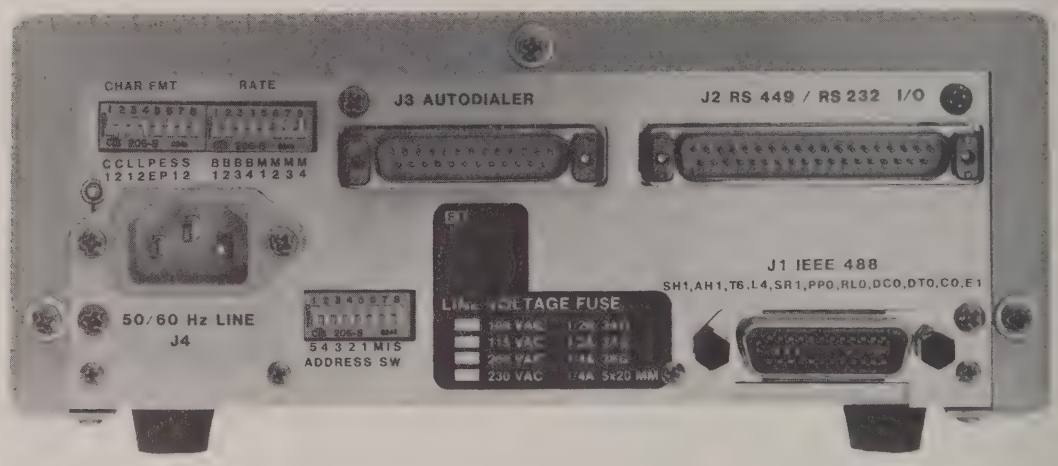



**Figure 3-1 4886B Rear Panel**

### 3.1.3 Character Format and Rate Switches

The rear panel contains a cutout for setting the Character Format and Baud Rate rocker switches. The Character Format defines the serial character used by the 4886B for all modes of operation and should be left in the factory setting which is:

| C1 | C2 | L1 | L2 | PE | EP | S1 | S2 |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |

One means the switch handle is in the up position; Zero refers to the down position. Table 3-1 shows the various RATE switch setting and their meanings.

**TABLE 3-1 RATE SWITCH SETTINGS**

| Switch Rockers | Position | Function |
|---|---|---|
| B1 B2 B3 B4 | | Selects Following Baud Rate for Async Modes |
| | 1100 | 110 bps |
| | 1010 | 150 |
| | 0110 | 300 |
| | 1110 | 600 |
| | 0001 | 1200 |
| | 1001 | 1800 |
| | 0101 | 2000 |
| | 1101 | 2400 |
| | 0011 | 4800 |
| | 1011 | 9600 |
| | 0111 | 19200 |
| | 1111 | 38400 |
| M1 M2 M3 M4 | | Selects the receive and transmit clock sources as shown below: |

| | T x C | R x C | J2-17[1] | Mode |
|---|---|---|---|---|
| 1100[2] | Int | Ext | 16x | Async |
| 0101[2] | Int | Ext | 1x | Async |
| 0110 | Ext | Ext | | Sync |
| 0111 | Int | Int | 1x | Async |
| 1111 | Int | Int | 16x | Async |

[1] J2-17 is the T x C out in Async Mode.

[2] This mode is not available in early units with 'E' Revision levels.

The following are typical RATE SWITCH settings for three applications:

| B1 | B2 | B3 | B4 | M1 | M2 | M3 | M4 | |
|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 300 baud async (103/113 Modems) |
| X | X | X | X | 0 | 1 | 1 | 0 | 9600 baud sync (High Speed Sync Modems) |
| 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 19200 baud async (back-to-back) |

### 3.1.4 Internal Function Switch

The internal function switch is located on the upper board just behind the baud and character format switches. This switch is used to tailor the 4886B's operation for unusual devices on the remote Bus or different operating requirements.

Position 1 - used with Reverse Autodial option. See paragraph 3.6.2.

Position 2 and 3 - Selects terminator(s) that will cause the remote extender to hold the remote Bus at the end of a device's talk message. This prevents unwanted data from getting into the exender's buffers.

Position 32

00 no remote hold

01 CR or EOI

10 LF or EOI

11 EOI only

Position 4 - When a "1", the 4886Bs' will clear their internal buffers on any SDC or DCL Bus command. (NOTE - always set both 4886Bs the same way.)

Position 5 - When a "1" changes the power on default from command 'F' to command 'E'.

Position 6 - Unused.

Position 7 - Unused.

Position 8 - Must be 0.

## 3.2 OPERATING INSTRUCTIONS

First time Bus Extender users should read Sections 3.2, 3.3 and 3.4 before proceding. Pay careful attention to paragraphs that discuss your intended system operation. Section 3.5 contains sample Bus controller routines for the extenders that can serve as a starting point for your programs.

### 3.2.1 Pre-Operation Setup

Before using the 4886B Bus Extenders, select the extender-to-extender communication method and fabricate the necessary extender-to-extender cables. Refer to Sections 2.6 and 2.7 for cable design information. Use standard Bus cables to connect the extenders to the other Bus devices. As a general rule, it is best to keep both extenders in the same room until the system is fully debugged. Next add the long cables or modems and a simulated telephone link. Finally, move the "remote" extender and its Bus devices to the remote site.

On the local extender, set its ADDRESS switch to an unused Bus address (see 3.1.2), its power switch to 115 or 230, and the CHAR FMT & RATE switches per Section 3.1.4. Plug the power cord into an ac power receptacle.

The remote extender's ADDRESS switch can be left at zero unless there is going to be a remote controller-in-charge or the extenders are being used in a multi-drop connection. If there will be a remote controller-in-charge of the Bus, the remote extender's ADDRESS switch should be set to an unused Bus address (see 3.1.2) so that it can be addressed by the remote controller.

In multi-drop applications, each remote extender should be assigned its own address. Here the remote extender addresses can duplicate the address of other devices on the busses since the remote extenders can only be addressed by the local extender. Set the M rocker switch ON on the remote extenders to place them in the multi-drop mode.

For multiple remote site applications, where the sites are accessed via the phone company's direct dial network, each remote extender's address switch should be set to the site number. The local Bus controller can later on use the 'W' command to read the switch setting to verify the site ID.

Set the remote extenders CHAR FMT & RATE switch to match the local extender's setting. Set the power switch to 115 or 230. Plug the power cord into an ac receptable.

### 3.2.2 Operation

Depress the 4886B's front panel POWER switch to turn power on. The POWER LED will stay off until the completion of the extender's internal self test routine. The self test lasts approximately 1 second, during which time the READY LED will be on. If the self test is successful, the POWER LED will come on and stay on. If the self test routine locates a failure, the front panel LEDs will start blinking the error code at a 2 cps rate. The error code is read left to right and POWER is the LSB. Table 5-1 can then be used to help isolate and repair the fault.

#### 3.2.2.1 TRANSPARENT BACK-TO-BACK OPERATION

After power turn on, the extenders normally enter the transparent back-to-back mode of operation without any further operator intervention. The extenders will turn their READY lights on indicating that the back-to-back cable is plugged into J2. The LINK light will come on next, showing that the extenders have verified that the remote extender is powered on and connected to the cable. The extenders will remain in a neutral state, verifying line connections, until an extender receives a BUS command. The extender at the controller end will establish itself as the local extender, and will pass the commands to the other extender, establishing it as the remote unit.

The Bus Controller can now proceed to send data and instructions to the devices on the remote Bus and receive data back.

### 3.2.2.2 DEDICATED LINE OPERATION WITH MODEMS

Operating with modems over a private cable or on a dedicated (leased) telephone line is basically the same as operating in the back-to-back mode described above. Here the READY light indicates the condition of the modem's CC and CF status lines. If these lines are not on, the modems are either not powered on, or, are not receiving a carrier from the remote unit. This condition must be corrected before proceeding.

### 3.2.2.3 DIAL-UP TELEPHONE LINE OPERATION

Dial-up telephone operations are more complex since,

a) The remote number must be called, answered and link verified before sending data.

b) Turn around times become longer and user must allow for slower overall transmission rates.

c) Data errors due to telephone switching spikes and cross talk are possible. The user should observe the ERROR and READY lights and dial a new line if the error rate become objectionable. Sometimes several trys are required to obtain a satisfactory line especially during periods of bad weather.

d) Auto-Dialer instructions must be added to the program if the extender's -A option is being used to dial the call. The user must read the local extender's status byte to determine if the call was completed satisfactorily.

e) Care must be taken to assure that all Bus transmission have been completed before disconnecting the call.

After power turn on and completion of self test, the extenders will become active with respect to BUS activity. If the extenders are not to be linked immediately but BUS transactions with other devices are going to take place, the local 4886B should be sent the 'I' command (Section 3.3.1) to avoid BUS slowdown and eventual hang up.

If the telephone link is being manually dialed, follow the instructions given with the data phones. When the call has been completed, press the data phones "DATA" button if required to shift the call from voice to the data mode. The data phones will then initiate the modem handshaking and complete the data link to the modems.

If the Auto-Dialer option is being used, the Bus Controller should use the N and T instructions to initiate the dialing sequences. The "DIALING" light will be on during this process and start blinking when the dialed number rings or if it is busy. Upon successful completion of the call, the READY and LINK lights should come on and the DIALING should be off. The 4886B will generate a Service Request to notify the controller of call completion.

The D instruction should be used to instruct the remote extender to terminate its output and drop off the line before addressing another extender.

#### 3.2.2.4 MULTI-DROP OPERATION

Multi-drop operation is similar to the dial-up telephone line operation described above, except that the controller uses the M instruction to address the remote extender. The D instruction should be used to instruct the remote extender to terminate its output and drop off the line before addressing another extender.

#### 3.2.2.5 REVERSE AUTO-DIAL OPERATION

Calls received from a remote 4886B using the reverse auto-dial feature will result in the local 4886B turning on the local SRQ line. The Bus Controller should then serial poll the local 4886B to learn that it has established a link with a remote 4886B. The Bus Controller should then be programmed to poll the devices at the remote site and take the appropriate action required to service their SRQ.

## 3.3 4886B INTERNAL INSTRUCTIONS

The 4886B Bus Extender can be addressed like any other Bus device, sent instructions, told to talk and be serial polled. These instructions affect how the extenders transfer data, clear their internal buffers and dial a telephone number using a Bell 801 type Auto-Dialing Unit. The 4886B must be addressed as a listener before it will accept any internal commands. The commands are strings of ASCII characters with meanings shown in Table 3-3. The commands may be separated by spaces, comma's, etc., or strung together at the user's convenience, with the exception of the 'D' command. When issuing a 'D' instruction, it should be the only instruction in the message. This command causes both 4886Bs to reset. This reset procedure takes between 1 and 2 seconds. The Controller should wait for the 4886B to generate a "can't communicate with remote 4886B" SRQ before proceeding. Programming examples incorporating this wait are given in Section 3.4.

### 3.3.1 Commands "A" and "I"

The "I" command causes the local extender to enter the idle mode and cease passing BUS activity to the remote extender. The local extender continues to verify the data path and presence of the remote extender. In the idle condition, the extender does not slow the Bus transfer rate down to the data link rate. The 'A' command will return the extender to the active state.

The 'I' command is used for two basic purposes. If device(s) on the Remote Bus are addressed infrequently, the 'I' command may be used to allow the Local Bus to run a full speed between Remote addressing times. If a problem has developed at the Remote site or the link has been lost, the 'I' command could be issued to allow the Local Bus to continue operation.

**TABLE 3-2 4886B INTERNAL COMMANDS**

| Command | 4886B Function |
|---|---|
| * A | Assume Active State |
| # I | Assume Idle State |
| E | Clear buffer of all remote data (except SRQ message) except on same Talk Address as last one sent |
| * F | Clear Buffer of all remote data (except SRQ message) on all Talk Addresses |
| * U | Add Un-Talk to Serial Poll Disable |
| V | Omit Un-Talk from Serial Poll Disable |
| * Q | Don't clear local transmit buffers on loss of data and SRQs enabled |
| R | Clear local transmit buffers on loss of data and SRQs enabled |
| N xxx T | Dial telephone number "xxx" |
| My | Address extender "y" in a multi-drop system |
| D | Disconnect a telephone or multi-drop extender |
| S | Generate SRQ after all data sent |
| X | Re-dial previous number |
| W | Updates byte 3 of the 4886's talk message with the remote extender's address switch setting |
| Bn | Stores a phone number (n = 1, 2, or 3) in the 4886B's Internal memory |
| Cn | Commands the extender to output the selected phone number when next addressed as a talker |

* power on condition
\# power on condition in Multi-drop mode

### 3.3.2 Commands "E" and "F"

The 'E' command prevents the extenders from clearing the remote transmit and local receive buffer if the new Talk Address was the same as the last Talk Address. The 'F' command causes these buffers to be cleared each time a Talk Address is sensed.

Some devices, designated Continuous Talkers, once addressed to talk, continue to send data (i.e., readings) until a new Talk Address (TAD) or UNTALK (UNT) is issued. If there is a Remote Continuous Talker, the delay of the serial link may allow this new TAD or UNT to arrive at the Remote Bus after an (unwanted) reading has already been sent to the Local BUS. Command 'F' overcomes this problem. Some Controllers, on the other hand, repeat a device's TAD before each new data string. In this case, the 'E' command would avoid destroying wanted data.

### 3.3.3 Commands "U" and "V"

The 'U' command causes the remote extender to add a Bus Untalk (UNT) command to the remote Bus output after each Serial Poll Disable (SPD) command. The UNT command prevents the remote device from sending (possibly) unwanted data over the data link. The 'V' command inhibits the addition of UNT after a SPD.

### 3.3.4 Commands "Q" and "R"

The Local extender will set Serial Poll Response bit 5 high upon loss of remote data or data link failure. If SRQs are enabled, a Service Request will be generated. If an SRQ is generated, commands 'Q' or 'R' will be acted upon. The 'R' command causes the local extender to clear its transmit buffer while command 'Q' inhibits the buffer clearing action (but not the SRQ function).

### 3.3.5 Command "N x x x . . x T"

Only for units with -A (Auto Dialer) option. The 'N x x x . . x T' character string is used to instruct the local extender to dial a telephone number. The extender treats the ASCII characters inserted between the letters 'N' and 'T' as the number to be dialed. The 4886B will only recognize the 16 characters in Table 3-3 as valid dialing characters. All other characters will be ignored. Therefore, the user can insert spaces or other delimiters in the string for his convenience without affecting the telephone number. A sample instruction to call ICS could be:

| | | |
|---|---|---|
| | N4082984844T | packed number without separators |
| or | N(408)298-4844T | number with separators for increased legibility |

A maximum of 31 characters may occur between N and T.

Note that some auto-dialers (such as Racal-Vadic) use the ASCII 'D' character as an instruction to wait for a dial tone before requesting the next number. The familiar "dial 9 for an outside line" could become:

N9D-555-1212T

### 3.3.6 Command "My"

The 'My' command string causes the local extender to address device in a Multi-Point Bus system. The remote Multi-Point extenders are addressed using the same characters as Bus Listen Address (1 thru 15 only).

For example, Command M#

Sends ASCII character '#' which addresses extender 03 (see Table 1-1) whose address switch setting is 00011.

The local extender's LINK light comes on when it has completed the data path to the selected remote extender and the extenders enter the active state.

**TABLE 3-3 ASCII DIALING CHARACTERS**

| ASCII Dialing Characters | RS366 Digit | V.25 Digit | J3 Signal States NB8 | NB4 | NB2 | NB1 |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 2 | 2 | 2 | 0 | 0 | 1 | 0 |
| 3 | 3 | 3 | 0 | 0 | 1 | 1 |
| 4 | 4 | 4 | 0 | 1 | 0 | 0 |
| 5 | 5 | 5 | 0 | 1 | 0 | 1 |
| 6 | 6 | 6 | 0 | 1 | 1 | 0 |
| 7 | 7 | 7 | 0 | 1 | 1 | 1 |
| 8 | 8 | 8 | 1 | 0 | 0 | 0 |
| 9 | 9 | 9 | 1 | 0 | 0 | 1 |
| A | *(star) | - | 1 | 0 | 1 | 0 |
| B | # | - | 1 | 0 | 1 | 1 |
| C | EON | EON | 1 | 1 | 0 | 0 |
| D | - | SEP | 1 | 1 | 0 | 1 |
| E | - | - | 1 | 1 | 1 | 0 |
| F | - | - | 1 | 1 | 1 | 1 |

### 3.3.7 Command "D"

The 'D' command causes the extender to disconnect the dialed up telephone line or Multi-Point data path and reset itself. The local extender disconnects the telephone line by lowering the RS-232 Data Terminal Ready and Request to Send lines along with the RS-366 Call Request Line.

### 3.3.8 Command "S"

The 'S' command causes the extender to generate an SRQ when the extender has successfully passed all the data in its buffer to the remote extender. The extender also sets bit DI06 in the serial poll response word to identify the out-of-data condition. The 'S' command is automatically reset when the SRQ is generated.

### 3.3.9 Command "W"

This command is transmitted to the Remote Extender which responds with a power-on setting of its address switch. When the local 4886B receives the response, it is stored in byte 3 of the 4886's Talk message. This command is used when the controller needs to know which Remote 4886B has called in response to a remote SRQ. This command is not used in multi-drop mode.

### 3.3.10 Command "X"

Only for units with -A (Auto-Dialer) option. This command causes the 4886B to dial the telephone number received with the last "Nxxx.....xT" command.

### 3.3.11 Command "B n N.....T"

Only for units with -A (Auto-Dialer) option. This command is used to instruct the 4886B with Auto-Dialer option to store telephone number n into its internal memory (n = 1, 2, 3). Command format is "B n N.....T", i.e. "B1N4082984844T".

### 3.3.12 Command "C n"

Only for units with -A (Auto-Dialer) option. This command asks the 4886B with Auto-Dialer option to confirm a stored telephone number by outputting the number to the Bus when addressed to talk. Confirming message format is C n N.....T, i.e. "C1N4082984844T".

## 3.4 HELPFUL HINTS FOR USING 4886B EXTENDERS

Under almost all operating circumstances, extending an IEEE Bus has no effect on overall system performance, with the exception of the slowdown incurred by the serial link. However, some situations can arise where advance knowledge can prevent possible problems.

### 3.4.1 An Active 4886B Without Link

An 'active' 4886B is one which handshakes with the IEEE Bus, either data or commands. A 4886B will handshake and put in it's buffer any transactions on the Bus when it is active. If a link is not established, this buffer may quickly become full. When the buffer is full, the 4886B will hold up the Bus until there is room in the buffer. Therefore if a 4886B is to not be linked for some reason (e.g., no need to communicate with remote Bus) that 4886B should be issued the 'I' command. Note this is not necessary in a Multi-drop mode because an unlinked 4886B is automatically inactive.

### 3.4.2 Remote SRQ

After power turn on, the 4886B's must still locate the current controller-in-charge in order that one 4886B may be designated the Remote extender. This is done when one extender handshakes a Bus CMD (ATN true) regardless of whether a link has been established. It becomes the local extender and the other 4886B is then designated the remote extender. Until this action takes place no SRQ's are passed between Busses. Some tests or demo systems may wait for an SRQ before proceeding after power turn-on or reset. Such systems should be modified to issue at least one Bus CMD (e.g., UNT or UNL) before waiting for the initial SRQ.

### 3.4.3 REN and IFC

REN and IFC are controlled by the System Controller. A single device in an interface (not necessarily the same as the controller-in-charge) controls REN and IFC and may not relinquish this ability to another device. Assuming that a link has been established, changes in these signals will be passed to the other Bus when they occur (Remote/Local not withstanding.) However, if REN and/or IFC are sensed at both Buses, the extenders will become confused and may not work properly. NOTE: If IFC is asserted before the extenders have determined their Remote/Local status, the extender at the other end will issue the IFC pulse and hold ATN true until it receives the next Bus command.

### 3.4.4 System Timeouts

Be aware that at low baud rates, device response times will be increased (i.e., Serial Polls of remote devices). Any programmed or system time-outs may need to be increased to allow for this lag.

### 3.4.5 Continuous Talkers and Internal Triggers

Section 3.2.2 describes the use of the 4886B 'F' command to overcome an anomoly introduced by Bus Extenders in a system with remote continuous talkers. Command 'F' will not overcome this problem if the Talker does not respond to an UNT by clearing it's talk buffer. This is often the case with state-counter controlled devices. Such devices will stop talking after an UNT, but will continue where they left off when next addressed to talk, resulting in an incomplete, and thus invalid, reading.

Continuous talking is most often a result of the device being programmed for internal trigger. Internal triggering allows the device to continually take readings. If the device is addressed to talk, every new reading is immediately handshook to the BUS. Many such devices (e.g., HP 3455 DMM's) recommend that an external or manual trigger be programmed when the device is on the BUS. Each reading can then be triggered by the controller issuing the GET BUS command (see Table 1-1). In order to avoid partial readings from remote state-counter driven devices in an extended BUS system where the serial link is slow (i.e., modems), this method of GET triggering must be used.

### 3.4.6 Remote Serial Polling

The IEEE-488 standard allows a Bus controller to serial poll a device by sending either the device's talk address (TAD) or the serial poll enable (SPE) command first. If TAD preceeds SPE, and they are transmitted between the 4886Bs in separate serial message blocks, and there is an error in the block with SPE, then the possibility exists that the remote device may begin to output data to the Bus rather than respond to a serial poll. This problem is more likely to occur at low baud rates ( 9600) since error correction takes longer at these rates.

One controller with which this problem can occur is Hewlett-Packard's 9825A. This problem can be overcome if the user forces SPE to occur before TAD. For the 9825A this is accomplished by replacing the statement "rds (704) → S" with the following sequence:

```
cmd7, char (24)
red 704, S$
cmd 7, char (25)
num (S$) → S
```

S$ must have been dimensioned to a length of one; this example serial polls Bus address 04.

## 3.5 USER PROGRAM AIDS

For most applications, a pair of 4886Bs may be inserted into an IEEE-488 Bus system with no changes to the Bus Controller's programming. This is particularly true in a back-to-back twisted pair configuration and in point-to-point dedicated-line w/modem operation. Other modes require some extra programming to initiate a link of the Local and Remote Buses (Auto-dial) or some routines to handle connect and disconnect of individual Remote 4886Bs (Multi-drop). The following section contains sample programs for the FLUKE 1720A and HP 9825 controllers. These sample programs can be easily modified for use on other IEEE controllers.

### 3.5.1 Auto-Dial Program for FLUKE 1720A

Figure 3-2 shows a sample program for a FLUKE 1720A Instrument Controller which will link two 4886Bs when the local 4886B is equipped with the -A option.

The program is a simple one which 1) assigns the telephone number to be called to the variable T$, 2) calls a subroutine which makes the link, and 3) prints a completion message. A line-by-line description of the program follows.

Line 10 - Program Header

Line 15 - Assign telephone number

Line 20 - Print informative message

Line 30 - Call subroutine at 100

Line 40 - Print completion message

Line 50 - Stop the program

Line 100 - Serial Poll the 4886B (at Bus Address 0) to clear the 1720A's SRQ flip-flop

Line 110 - Give 4886B dialing information

Line 120 - Wait for SRQ from 4886B before proceeding

Line 130 - Initialize the variable A$ with a completion message

Line 140 - Performs a Serial Poll of the 4886B

Line 150 - If the Serial Poll shows that the call was not completed, the message in A$ is corrected

Line 160 - Return to mainline

Line 999 - End of program

```
10   ! Auto-dial example
15   T$ = "275-1689"
20   PRINT "Dialing phone number"; T$
30   GOSUB 100
40   PRINT "Call is "; A$
50   STOP
60   !
100  Y% = SPL (0%)
110  PRINT @0%, "N"; T$ ; "T"
120  WAIT FOR SRQ
130  A$ = "COMPLETE"
140  Y% = SPL (0%)
150  IF Y% AND 16% THEN A$ = "INCOMPLETE"
160  RETURN
999  END
```

**Figure 3-2 Auto-Dial Program for FLUKE 1720A**

### 3.5.2 Auto-Dial Program for Hewlett-Packard 9825

Figure 3-3 shows an HP9825 Desk-top calculator program equivalent to the FLUKE 1720A program of Figure 3-2. In the HP program, the telephone number is fixed in the 'CALL' subroutine while the 4886B Bus address is assigned to a variable in the main program. The program does the following:

Line 0 - Program heading

Line 1 - Reserve space for string variable whose maximum length is 10 characters

Line 2 - Assign 4886B's Bus address (0) to device variable

Line 3 - Disable IEEE interrupts

Line 4 - Display informative message

Line 5 - Call subroutine to give dialing instructions

Line 6 - Display result of attempt at Link

Line 7 - Stop the program

Line 8 - Subroutine label

Line 9 - Serial Poll 4886B to clear power on SRQ

Line 10 - Specify IEEE SRQ interrupt routine

Line 11 - Initialize J

Line 12 - Give 4886B dialing instructions

Line 13 - Enable IEEE interrupts

Line 14 - Implement 'wait for SRQ' statement

Line 15 - Return to main program

Line 16 - Interrupt routine label

Line 17 - Set 'SRQ occurred' flag

Line 18 - Initialize completion message

Line 19 - Serial Poll 4886B

Line 20 - If call incomplete, negate completion message

Line 21 - Disable IEEE interrupts; return (to CALL subroutine)

Line 22 - End of program

```
0: "Autodial
 example":
1: dim A$[10]
2: dev "4886",
 700
3: eir 7,0
4: dsp "Dialing
 phone number"
5: cll 'CALL'
6: dsp "Call
 is",A$
7: stp
8: "CALL":
9: rds("4886")→S
10: oni 7,"SRQ"
11: 0→J
12: wrt "4886",
 "N 275-1689 T"
13: eir 7
14: J+1→J;if
 J#0;gto -0
15: ret
16: "SRQ":
17: -1→J
18: "COMPLETE"→A
 $
19: rds("4886")→
 S
20: if bit(4,S);
 "IN"&A$→A$
21: eir 7,0;iret

22: end
*1107
```

**Figure 3-3 Auto-Dial Program for HP9825**

### 3.5.3 Multi-Drop Link/Unlink Subroutines

Figure 3-4 shows a subroutine (written for a FLUKE 1720A Controller) which can be used in a Multi-drop IEEE Bus system. The variable I% contains the decimal equivalent of the ASCII character corresponding to the Multi-drop address of the Remote 4886B to be linked.

For example, referring to Table 1-1, if the Remote 4886B's address is 4, its corresponding ASCII character is '$', the hex value is 24 and the equivalent decimal value is 36.

The following is a line-by-line description of the program.

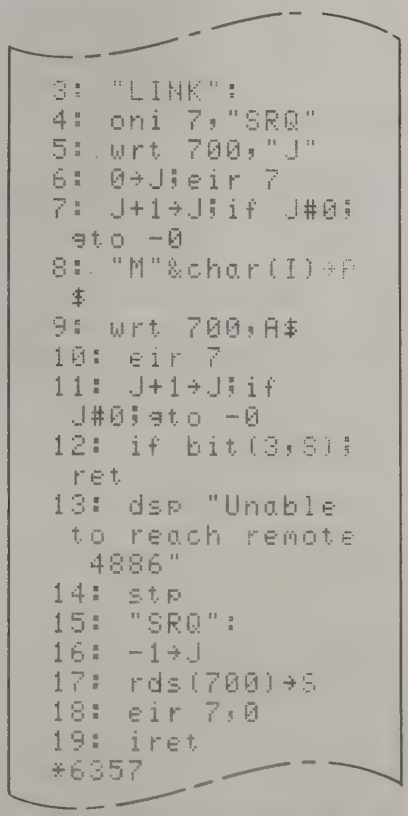
Line 500 - Send disconnect to local 4886B at Bus address 0
Line 510 - Clear the 1720A's SRQ flip-flop
Line 520 - Wait for 4886B to generate SRQ caused by disconnect
Line 530 - Clear the 1720A's SRQ flip-flop
Line 540 - Instruct link to Remote 4886B
Line 550 - Wait for Complete/Incomplete SRQ
Line 560 - Serial poll the 4886B
Line 570 - If link complete return
Line 580 - Link incomplete; print message
Line 590 - Stop
Line 600 - End of program

```
500     PRINT @0%, "D"
510     Y% = SPL (0%)
520     WAIT FOR SRQ
530     Y% = SPL (0%)
540     PRINT @0%, "M"; CHR$ (I%)
550     WAIT FOR SRQ
560     Y% = SPL (0%)
570     IF Y% AND 8% THEN RETURN
580     PRINT "Unable to reach remote 4886B"
590     STOP
600     END
```

**Figure 3-4 Multi-Drop Subroutine for FLUKE 1720A**

Figure 3-5 is a similar subroutine for an HP9825A. The variable I corresponds to I% in Figure 3-4. The program steps are:

| | | |
|---|---|---|
| Line 3 | - | Subroutine label |
| Line 4 | - | Set up SRQ interrupt routine address |
| Line 5 | - | Write disconnect command to 4886B (at Bus address 0) |
| Line 6 | - | Initialize J; enable interrupts |
| Line 7 | - | Implement 'WAIT FOR SRQ' |
| Line 8 | - | Set up Multi-drop address string |
| Line 9 | - | Write Multi-drop address string to 4886B |
| Line 10 | - | Enable interrupts |
| Line 11 | - | Implement 'WAIT FOR SRQ' |
| Line 12 | - | If 'CONNECTION COMPLETE' then return |
| Line 13 | - | Display message |
| Line 14 | - | Stop program execution |
| Line 15 | - | SRQ routine label |
| Line 16 | - | Set J flag |
| Line 17 | - | Serial Poll 4886B |
| Line 18 | - | Disable Bus interrupts |
| Line 19 | - | Return from interrupt |



```
3: "LINK":
4: oni 7,"SRQ"
5: wrt 700,"J"
6: 0→J;eir 7
7: J+1→J;if J#0;
 gto -0
8: "M"&char(I)→A
 $
9: wrt 700,A$
10: eir 7
11: J+1→J;if
 J#0;gto -0
12: if bit(3,S);
 ret
13: dsp "Unable
 to reach remote
  4886"
14: stp
15: "SRQ":
16: -1→J
17: rds(700)→S
18: eir 7,0
19: iret
*6357
```

**Figure 3-5 Multi-Drop Subroutine for HP 9825**

Both subroutines assume the inability to complete a link to be a fatal error and stop. An alternate action would be to set a flag in the subroutine indicating Complete/Incomplete and let the main program decide what action to take.

## 3.6 AUTO-DIALER OPTION

The -A option gives the 4886B the ability to dial telephone numbers and establish phone links with another 4886B. At the local site, the extender places the call in response to commands from the Bus controller. At the remote site, the extender senses an active SRQ input and calls numbers prestored in its internal memory. In both cases, the 4886B's auto-dialing connector, J3, is connected to an 801 A, 801 C or equivalent auto-dialer as described in Section 2.7.

### 3.6.1 Local Auto-Dial Capability

The Bus controller initiates the call by sending the local extender the "N" command with the number to be dialed (see paragraph 3.3.5). The extender turns on its DIALING LED while dialing the number. The DIALING LED stays on until (1) the call is complete and the LINK LED comes on, or (2) the number is busy and the DIALING LED begins blinking. The local extender generates an SRQ and sets the appropriate bits in the serial poll response word to inform the controller that (1) the call was completed and link established to the remote extender, or (2) call failed after three tries.

### 3.6.2 Reverse Auto-Dial Capability

A Remote 4886B which is not linked can be made to call a local 4886B upon the detection of an SRQ on the remote Bus. This implementation is referred to as Reverse-Auto-Dial and requires the following 3 steps:

1) Store the phone numbers (3 max.) to be dialed in the 4886B's memory before installing it in the remote location. To store the numbers, connect the extender to a Bus Controller, address the extender as a listener and send it the "B n N.....T" command. Use the 'C n' command and address the extender as a talker to verify the stored phone number.

2) Set the address switch 'S' up

3) Set the lsb of the 8-bit switch on the Serial I/O card (top PC board) to the '1' position

NOTE: The Reverse Auto-Dial 4886B will handshake one UNTALK command on the BUS when it powers up or is reset.

# 4

# Theory of Operation

## 4.1 BLOCK DIAGRAM DESCRIPTION

The 4886B IEEE 488 Bus Extender block diagram is shown in Figure 4-1. The 4886B Extender is a microprocessor based device that extends the distance between standard instruments on the IEEE 488 Instrument Bus. Each 4886B Extender contains the 488 Bus Driver-Receivers, Program Memory, Microprocessor and Input Logic. Serial I/O Drivers-Receivers (both RS-232 and 449) are located on the top PC board.

The 488 Bus Driver-Receivers transfer data between the IEEE 488 Bus and the internal microprocessor. The microprocessor serializes this data in a private protocol and transmits it to another 4886B where it is decoded and transferred to the IEEE Bus.

The 4886B will output status information to the Bus by responding to a Serial Poll. The 4886B responds to a Serial Poll by placing an 8 bit character on the Bus data lines. Each bit represents such conditions as Instrument Ready Status, Remote SRQ Status, and 4886B Service Request (see Section 1.2.6.4 for bit assignments).

The 4886B Bus Extender operation is controlled by a program stored in the PROM memory. The microprocessor follows this program to transfer data, status, and command functions between the 488 Bus connected to one 4886B and the 488 Bus connected to another 4886B.

## 4.2 DETAILED LOGIC DESCRIPTION

### 4.2.1 **Main Board** (See Figure 7-1, Sheets, 1, 2 and 3)

The 4.9152MHz microprocessor clocks Ø1 and Ø2, are generated by an oscillator formed by U1, Y1, and Q1. Memory and circuit addressing is accomplished by a 16-bit address bus. The lower ten bits directly address the memory byte; the upper four bits operate a decoder, U11, which selects the device being addressed. Address bits 10 and 11 define the type and size of memory at socket locations U3 through U6 (PROM or RAM, 1k, 2k, or 4K) via jumpers. Data is transferred to the microprocessor on a bi-directional bus. Data buffer U15 extends the microprocessor data bus to drive the circuits in the Bus and Output Logic sections. Capacitor C7 and resistor R6 are used to generate the power on clear pulse. Reset button S2 shorts the capacitor to ground to generate a manual reset pulse.

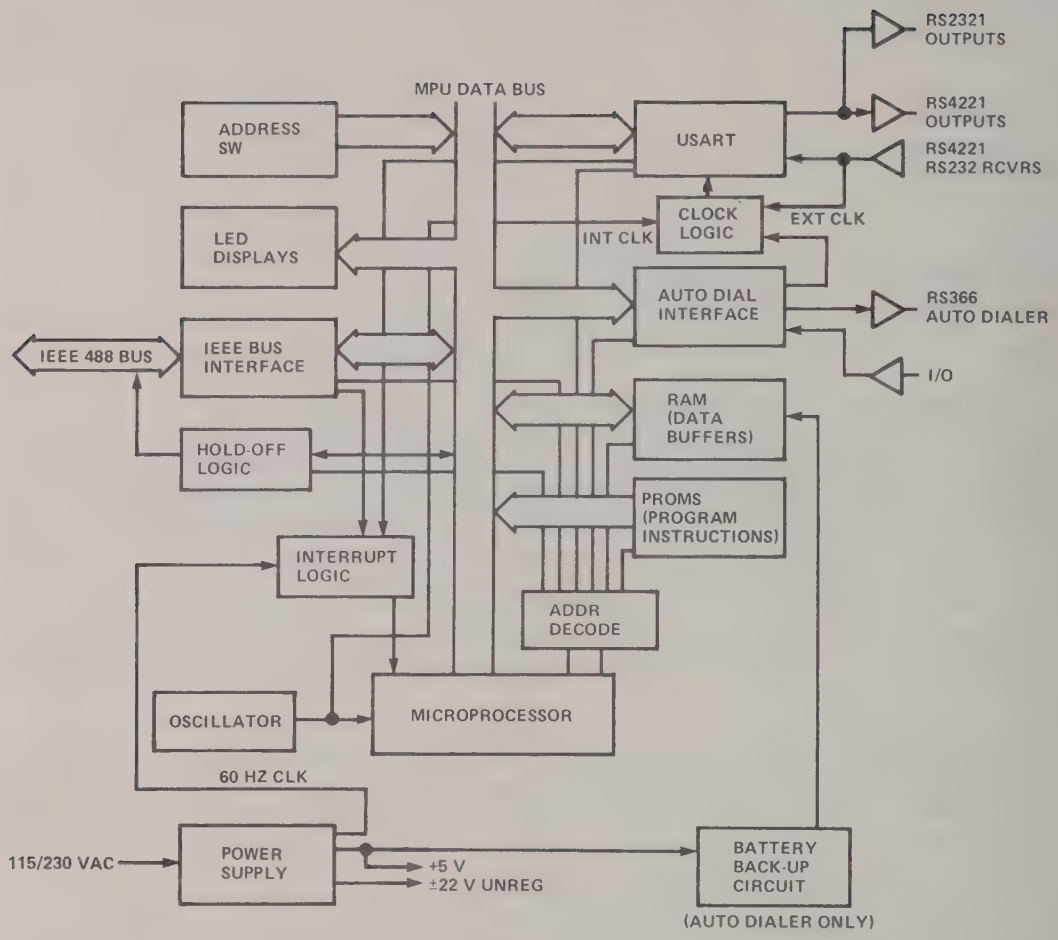



**Figure 4-1 4886B Block Diagram**

Register U13 prioritizes the various interrupt types and notifies the microprocessor that an interrupt condition exists. During the microprocessor's interrupt acknowledge cycle, the lower 8 bits of the interrupt vector are transferred to the data bus via buffer U14. The microprocessor combines the lower 8 bits with the pre-stored upper 8 bits to form the complete interrupt vector. The interrupt vector is the microprocessor's entry address into the interrupt vector table. Subroutines pointed to by the interrupt vector table within the PROM program memory handle the various types of interrupts. The three (3) levels of interrupts from highest priority to lowest are: top board interrupts, 488 Bus interrupts and 60Hz interrupts. U25 and U29 lockout re-interrupts of the same level and all lower order interrupts while an interrupt is being serviced.

IEEE Bus signals are transferred to and from the microprocessor via the Bus Interface circuit U19 and Bus Transceivers U18 and U23. Decoder U24 provides address strobes for the Bus Interface, address switch S5, and the front panel display logic. Two of these address strobes clock the two latches U27 and U31. Latch U27 configures the 488 Bus Control Line Transceiver's (U23) Bus Controller status as either a device or a Controller, and U18 as the 488 Bus Data Transceiver as either open collector or tri-state. The 4886B Extender's initialization table configures U18 as open collector. U23 may be either a device or Controller depending on the system configuration.

With jumper N-N installed, U31 provides for an auxillary handshake hold-off for the Bus Interface circuit U19. When in the Listen Mode and on the leading edge of DAV true, U31 holds NDAC low (true) until reset under program control by decoder U24. Jumper N-N is omitted when handshake hold-off is not required such as in the 4874 Interface. The second half of U31 is used to latch the fact that a Parallel Poll has occurred until the processor interrogates U31 with ST44. Upon recognition of a Parallel Poll, the Local 4886B passes this fact to a Remote 4886B which causes a Parallel Poll at the extended Bus. The response to this Remote Parallel Poll is passed back to the Local 4886B where it may be read by the Controller.

Latch U22 accepts updated front panel display information from the microprocessor's Internal Extended Data Bus on receipt of strobe ST41. This strobe is generated by decoder U24 as a negative going pulse which is inverted to positive going by U20. The outputs of U22 are inverted by buffers U26 and U28 so that a 1 bit on the data bus, once latched, will result in an LED being ON. Address data from switch S5 is gated through U10 on receipt of strobe ST42, a negative going pulse generated by U24. Gate U10 is inverting so that a switch being closed (ON) causes the appropriate bit appearing on the Internal Extended Data Bus to be a 1.

Units equipped with the -A option contain a lithium battery B1 and a low power CMOS memory IC in place of the normal MOS IC at U6. The low-power memory is used to store phone numbers for Auto-Dialer applications when the AC power is turned off. Transistors Q3 and Q5 supply power to U6 for power on operation. Latch U22 and transistor Q4 enable buffer U9 to route the W, CE and OE signals to U6 so as not to disrupt memory during power turn-on and turn-off.

AC power is brought through the 115/230 Vac selector switch S4. A PC board jumper sets the transformer for a nominal 100 or 115 Vac input level. Switching regulator U16 sense low output voltage and turns the series pass transistor switch on until the output capacitor reaches the proper output value. Current continues to flow through the series choke L1, until the voltage again drops below the threshold point. Output capacitors C11 and C12 filter the chopped DC current and produce a smooth 5 Vdc output with less than 100 mV of ripple.

### 4.2.2 **Serial I/O Card** (See Figure 7-2 sheets 1 and 2.)

This Serial I/O card contains the following major functions: Power regulation, serial-to-parallel conversion, RS-232/RS-449 interfaces, RS-366 (Auto-Dialer) interface, and baud rate clock generation. Q1 is a 3 terminal regulator which provides -5V to the RS-232 drivers. The USART (U26) converts the serial input data into parallel form and parallel data into the output serial bit stream. When the USART has received a serial character, it lowers the RXRDY signal which generates the interrupt DR to which the processor responds. Reading address 6008 raises RXRDY and loads the received data (D0-D7) onto the microprocessor data Bus from the USART's Receiver Hold Resistor. Address 6009 Reads the USART Status Register. Address 600B reads/writes the USART command register. When TXRDY goes low, the USART's Transmit Hold Register can be loaded at address 6008. All decoded address lines are enabled only during a read/write time by the W/DIN signal.

Baud rates are generated internally by the USART using the BCLK input at Pin 20. Alternately the USART may use externally generated Receive and/or Transmit clocks available from connector J2 or divider chip U18. The CHAR FMT, BAUD RATE, and EOM/SYN CHAR switches are read by the microprocessor to program the USART. Receivers U6, U11, and U13 convert the RS-449 serial data signals and levels to TTL levels. Drivers U5, U7, and U14 convert levels TTL serial data to $\pm$12V output levels. U4 (and 1/4 of U11) convert the Auto-Dialer input signals to TTL levels, while U16 and U17 convert TTL to Auto-Dialer outputs.